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# REMARKS ON FOSSIL SHELLS FROM THE COLORADO DESERT.[1]

BY ROBERT E. C. STEARNS.

A LUMP of earth from the Colorado Desert which it is here proposed to investigate, is not without interest. It is part of a much larger piece recently brought from Walter's station, a point on the Southern Pacific railroad, in California, where it was selected by Prof. Geo. Davidson, who has furnished the special facts as to locality.

It is composed of clayey sediment, and was brought to the surface, from near the bottom of a well recently sunk by the railroad company at the above named place, during the process of digging through the dry deposit in a forty-inch tubing (an old smokestack). At forty-five to forty-seven feet the water-bearing stratum was struck, when the water burst up and filled the tube to within twelve feet of the surface. The continuous pumping out of a two and a-half inch stream does not lower the water line in the well. The lump, it will be noticed, contains many small shells. The larger portion of the original piece readily dissolved in hot water, in which it at once separated. Thinking it might contain diatoms or other minute microscopic forms, some of it was examined by Dr. A. M. Edwards, without, however, any being detected. The shells, though small, are easily seen without a lens, are all fresh-water forms and are also found in great numbers (sometimes in windrows) at various places on the surface of the desert.

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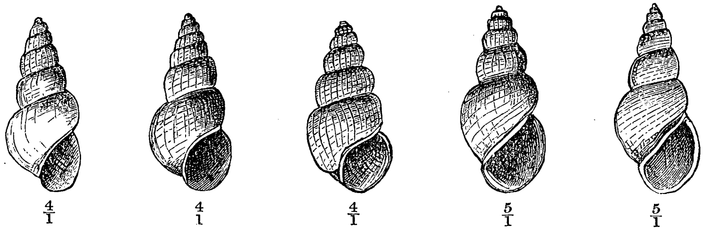
[1] Read before the California Academy of Sciences.

*Physa humerosa* Gould. Natural size.

One of the species from the well is *Physa humerosa* Gould, of which there is a single specimen; the others, of which there are numerous examples, are *Tryonia clathrata* Stimpson, and *Tryonia protea* of Gould. These latter belong to the family of *Rissoidæ,* and were described several years ago from specimens collected by Prof. Wm. P. Blake. They have also been collected by several other parties. From the late lamented Col. Albert S. Evans,[1] I received, several years ago, half a pint of these desert shells, and from others I have received a great number; probably altogether as many as 40,000 specimens have passed under my inspection, including the above and a single species of *Amnicola* (*longinqua* Gould), as well as fragments of a *Planorbis* and of *Anodonta californiensis* Lea. It is not unlikely that if we had a sufficient quantity of sediment from the well, we should find that it contained all of these forms. All of the great number of specimens which passed under my observation, are in a fossilized or semi-fossilized condition, either of a clear opaque white (in this respect resembling the fossils of the Paris basin), or more or less translucent, though more or less silicified, while the delicate sculpture is as perfect as ever.



*Tryonia protea* and varieties (semi-fossil). Colorado Desert, Cal. From nature, by Stearns.

The surface of the desert at the point where the well is situated is 195.54 feet below the level of the ocean, as indicated by the barometer. Shall we indulge in a guess as to the depth of the water when these shells were alive; shall we add the depth of the well to the above figures, and again add the elevation of bench-marks, the ancient levels[1] which form terrace lines in some places along the distant hills, once a part of the shores of a now extinct lake, the walls of the basin which once enclosed and held a fresh-water sea?

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[1] Col. Evans was lost at sea, while on his way from New York to Brazil, by the burning of the steamship *Missouri* off the Bermudas.

It may have been, however, that the lake was never as deep as the figures thus added would indicate, and that instead of a lake or series of lakes, there existed only a lagoon or chain of lagoons, connected or disconnected, according to the volume of water, which probably varied one season compared with another; a system of shallow reservoirs, receiving the catchment or surplus surface water in periods or seasons of unusual rainfall; sometimes after a prolonged and widespread storm of great severity, uniting and forming an extensive expanse a few feet only in depth, as was seen in the valleys of California during the notable winter of 1861–2.

The rate of depression may have been such as to continue to keep the lagoons supplied during ordinary seasons with catchment or surface water from the immediate neighborhood, and have been so proportioned (involving the mean of supply) to the rate of evaporation, that only within a very recent period has this depressed portion of the Colorado basin become bare and dry.

Are the phenomena which this vast and remarkable region exhibits—of which that portion usually called the desert, is but a part—the result of catastrophic action, sudden, violent and widespread, or the result of gradual changes moving slowly through countless centuries?

The physiognomy of the wider and more general region in some of its aspects indicates action which, in geologic time is unmistakably recent, and the varied phenomena here exhibited, are more likely the result of periods of slow movement as well as periods of convulsive action, recurring cycles of sudden and of gradual changes, operating through different but succeeding geologic ages or periods of geologic time. Prof. Whitney has pointed out the coincidence of mountain peaks of extraordinary elevation and areas of extraordinary depression (below the sea level), which are a part of the peculiar characteristics and striking topographical features of the same general area.[1]

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[1] For miles and miles I traced with the eye a strange, well-defined line along the mountain sides, always at the same level * * * Riding out to it I found it to be the old beach of a sea.

The rocks were worn and rounded up to that level, * * * above that line the rocks were sharp and jagged. The surveying party of the Southern Pacific railroad, in running the line to Fort Yuma, struck the present sea-level the moment their instruments reached this ancient beach.—*Dr. J. P. Widney in Overland Monthly, Vol. x, 1873.*

During the pliocene epoch the site of the present desert was occupied by the sea or was, perhaps, a part of the Gulf of California.

"Beds of * * * Miocene and possibly Pliocene fossils are found at the mouth of Kern River cañon, showing that the sea then washed freely against the foot of the Sierra; there is even reason for believing that it extended far up the Colorado River basin; and certainly it deposited a thick bed of the enormous Miocene oyster (*O. titan*), with other remains along the west shore

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[1] For most interesting information as to the height of mountains, the depression of Death and other valleys, saline plains, alkaline lakes, mud volcanoes and other phenomena which mark the physiognomy and relate to the general aspect of this wonderful region, attention is directed to Vol. i, Geol. Survey of Cal. (by Prof. Whitney), also Whitney in Proc. Cal. Acad., Vols. ii, iii and iv; Veitch in Vol. i, *id.*; Col. Williamson in Vol. iii, *id.*; Cooper in Vol. v, *id.*, and Lieut. Wheeler's Annual Report for 1876. Another author, Dr. J. P. Widney, from whose interesting article in the *Overland Monthly* (January, 1873) I have previously quoted, writes as follows of the Colorado Desert.

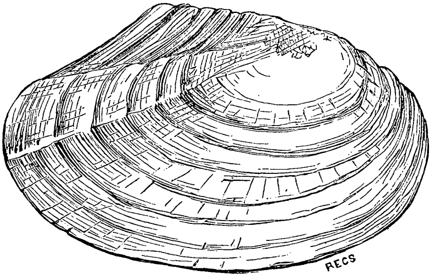
Crossing by the San Gorgonio Pass, the continuation of the Sierra Nevada range back of San Bernardino, the traveler leaves the fertile coast valleys [of California] and enters upon what appears * * * * the * * remains of some ancient world. As he came through the * * pass, upon his right towered San Gorgonio Peak, * * 10,500 feet in height. Upon the left forming the other wall of the pass, pine-clad San Bernardino * * reaches an altitude of 11,500 feet. But leaving now the mountains behind he descends into what seems the scorched, blasted bed of some old cyclopean furnace * * * San Gorgonio and San Bernardino on this side have lost their pines, and brown, barren and desolate, frown down upon yet greater desolation. Upon the west * * * stretch the Sierra in an unending line—a forbidding rugged wall. At the north, a spur from this main chain turns off eastward, and then curving around bears to the south, parallel to the Sierra, making another abrupt wall, which at last drops down and is lost near Fort Yuma. Inclosed by these mountains, open only toward the south, where 200 miles away it faces out upon the waters of the Gulf of California, is the Colorado Desert.

Surrounded upon every side by mountains, except in one direction, and there opening out upon the head of the Gulf of California; it shows that the desert is a portion of the old gulf which then extended 200 miles above its present limit. The cause of the separation of the upper end of that gulf, making what is now the Colorado Desert, is so apparent, that a moment's examination reveals it. The same of the present Colorado desert, now at an elevation of probably 1000 feet."[1]

The sedimentary deposits super-imposed upon the more ancient sea or gulf bed, the top of which now constitutes the floor of the desert are geologically of very recent origin.

The perpendicular section of nearly fifty feet cut by this well, as shown by the character of the stratum cut through in connection with the shells contained therein, indicates a gradual deposit, a slow settling of sediment; the fragility of the shells and their present unfractured condition, prove that they were never subjected to abrasive action; that they were not swept violently from distant places to this, and here buried pell-mell beneath and among the varied detritus of great freshets.

Here probably was the home of *some* of these species, the metropolis of *Tryonia*, if not its specific center, which has only been found sparingly elsewhere, and was supposed to be extinct. Ninety per cent., if not more, of the shells found here belong to this genus.



*Anodonta californiensis* Lea. Rio Colorado, Cal.

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agency is still at work, widening the space between the Gulf and the desert. Here nearly 150 miles from the head of the ancient gulf came in from the east side the Colorado River, bearing in its thick floods, quicksands and the red mud from the great plateaus of northern Arizona which gives the river its color and its name. The contour of the country shows the gulf to have been narrow here. The filling in of this alluvial deposit went on unceasingly, as at the mouth of every great river which enters the sea at a sheltered point. The water grew constantly shoaler, until at length the separation was complete. The alluvial deposit has steadily increased the distance between the gulf and the low bed of the desert, until now the division is marked by a narrow neck of thirty or forty miles of land but little raised above the sea level. (Dr. Widney, in *Overland Monthly*, Vol. x. See also various papers on Arizona, &c., and the Colorado river, in Vols. iv, vi, and ix, *id.*)

[1] Cooper in Proc. Cal. Acad. Sci., Vol. v, p. 403.

Mr. Tryon reporting on certain shells collected by Lieut. Wheeler's expedition in Utah Territory, says,

> "Included in the collection are two specimens of the genus *Tryonia* Stimpson. This curious little genus was heretofore considered to be restricted to the Colorado Desert of southern California. * * Two species have been described, viz: the type *T.* (*Melania*) *exigua* Conrad, of which *Melania protea* Gould is a synonym, and *Tryonia clathrata* Stimpson. The two Utah specimens are probably *T. exigua.*"[1]

The lump of earth from which the specimens mentioned were obtained was about the size of one's fist, yet this comparatively small matrix contained as many as three hundred. What an inconceivable number must have been propagated and buried here, what numberless generations have been born and died, since the lowest foot in this perpendicular well-section was deposited, to the last and most recent deposit, when the present surface was reached and completed! If the mind is unable to comprehend what is equally imperceptible to the eye, the numbers buried *beneath* the surface, the mind also fails to comprehend what *is* visible to the eye, the vast number which are seen *on* the surface of the desert in crossing it, the external skeletons of the vast multitude left on the top of the last deposit, when the last inch of water evaporated and left a sterile and windswept waste, upon which to-day are scattered untold millions of these tiny forms.

If we may assume that the species to which these forms belong no longer exist, within the more special area under consideration, they must have become extinct within geologically a very recent time. An examination shows the sculpture to be wonderfully sharp and well defined, yet probably the life of these minute organisms, that is to say, the specific life, had an earlier genesis than that of the human race, and the particular specimens before us were living, at a time, prior to the appearance of man on the planet.

We have here also an illustration of the relation of life and species to environment, as shown in the extinction of the former, through a radical change in the latter.

In connection with the total evaporation of the former lake or lagoons as above, it should not be inferred therefrom that the particular portion of the desert incidentally under consideration, has been permanently and continuously dry ever since the extinction of *Tryonia,* but that through evaporation, *it ceased to be permanently covered* with water, and though since at various times, a greater or less area has been so covered—the extinction of *Tryonia* proves that there must have been a period of drouth, a maximum both as regards degree and duration which destroyed the limited fauna, the few species which once existed here—though some of the species which I have named belonging to the genera, *Anodonta, Physa,* and *Planorbis,* having an earlier genesis, are known to have a wider distribution, and migrated hither, as they are still found living in regions more or less distant, as will be shown farther on; and it is barely possible that a living colony, a remnant of *Tryonia* may yet be discovered somewhere within the desert area.

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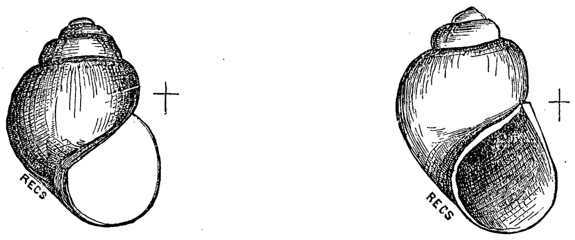
[1] Proc. Phil. Acad. Nat. Sciences, May 1, 1873.

It has been implied herein that the metropolis of the form called *Tryonia* was here in the former lake or lagoon region of the Colorado desert or basin, for the reason of the great multitude of individuals; its specific center may have been far to the north, nearer to the point from which the Wheeler specimens, referred to by Mr. Tryon, were obtained; it has not been found and is not known to be living elsewhere, at the present time. As to the other molluscan forms which once lived here and are now found dead either at or below the surface, an inquiry as to the localities where they are still found living,[1] and the probable paths of distribution which brought them together as congeners or neighbors of *Tryonia,* incidentally furnishes further information pertaining to the specific region formerly occupied by these species.



*Amnicola longinqua* Gould (showing range of variation). Drawn by Stearns from recent specimens collected by Henry Hemphill, in Utah Territory.

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[1] *Amnicola longinqua,* has recently been collected *living* in Utah by Mr. Hemphill.

An examination of Lieut. Wheeler's Drainage Map[1] of the territory west of the one hundredth meridian, shows the position of the Colorado as related to the other basins, to be diagonal, its general trend being north-easterly and south-westerly.

> "The region of country drained by the Colorado and its tributaries is about 800 miles in length and varies from 300 to 500 miles in width, containing about 300,000 square miles, an area larger than all the New England and Middle States, with Maryland and Virginia added, or as large as Minnesota, Wisconsin, Iowa, Illinois and Missouri." [2]

While it may be presumed that these forms so intimately related have gradually through a great period of time spread from the higher altitudes to the lower, from the older formations to the more recent, extending the area of their distribution as fast as the emergence of the land above the sea and the emerged surface had undergone those modifications necessary to fit it for their occupancy, and are still spreading to new localities; so perhaps in other portions of the area of their domain they are decreasing or dying out, or have already died out, through modifications in the environment as in the now dried up lake or lagoons of the Colorado desert.

It is highly probable that at numerous places within the great interior basin, after the emergence of the land, fresh water lakes, ponds and streams occurred and existed for a time, and became peopled, in part by fluviatile species, such as we are now considering, including varieties of the mussels, intermediate and connecting links between the desert specimens and those from the Wahsatch stations referred to.

It is to be expected that in course of time when this great interior wilderness is thoroughly explored, that living specimens will also be found in those streams and lakes whose waters are still sweet; and with a sufficient number of specimens living and fossil from these two classes of stations, we may be able to trace the lines of distribution, which followed not alone the direct course of streams, for instance like the Colorado, but descended also to the great basin from the now lofty altitudes of the Sierra Nevada, and the parallel ranges on its eastern flank on one side, as from the corresponding regions in the Wahsatch range and subsidiary ranges upon its western flank on the other, spreading laterally as well as in the direction of what may be regarded as the great highways furnished by the main stream and its principal confluents.

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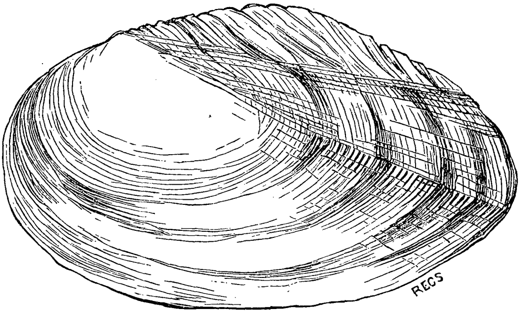
[1] In Lieut. Wheeler's Annual Report, 1876.

[2] Exploration of the Colorado of the West, etc., by Prof. J. W. Powell, 1875, p. 3.

That we may have a better idea of the Colorado river and its tributaries, and of the regions traversed by the latter, I will quote the eloquent description of Prof. Powell.

> "There are two distinct portions of the basin of the Colorado. The lower third is but a little above the level of the sea, though here and there ranges of mountains rise to an altitude of from two to six thousand feet. This part of the valley is bounded on the north by a line of cliffs, which present a bold often vertical step, hundreds or thousands of feet to the table lands above.
>
> The upper portion of the basin rises from four to eight thousand feet above the level of the sea. This high region on the east, north and west, is set with ranges of snow-clad mountains attaining an elevation above the sea varying from eight to fourteen thousand feet. All winter long on its mountain crested rim, snow falls, filling the gorges, half burying the forests, and covering the crags and peaks with a mantle woven by the winds from the waves of the sea—a mantle of snow. When the summer sun comes, this snow melts, and tumbles down the mountain sides in millions of cascades. Ten million cascade brooks unite to form ten thousand torrent creeks; ten thousand torrent creeks unite to form a hundred rivers beset with cataracts; a hundred roaring rivers unite to form the Colorado, which rolls, a mad, turbid stream, into the Gulf of California."



Anodonta. Owen's River, Cal.

While the specimens from Washoe lake are in every feature so close to those from Bear river in the distant Wahsatch range, the mussels inhabiting Owen's river at an elevation of 4000 feet on the easterly flank of the Sierra Nevada, exhibit a considerable variation when compared with those from the preceding places.[1]

The Owen's river specimens, though inhabiting so elevated a station, closely resemble those found at, and in the neighborhood of Los Angeles at an elevation of only 280 feet, and the specimens from both of these places as well as specimens from other stations with similar elevations within the southern portion of the limits of the coast drainage area of California as shown in Lieut. Wheeler's map, and which stations more closely approximate to the level of the desert region, are exceedingly close in their general aspect and minuter characters to the dead shells of the extinct lagoons, and to Lea's type[2] from the Colorado, presumably in the neighborhood of Fort Yuma. At many points within the drainage area described in the foregoing reports the *Anodontæ* have been detected.

I am under obligations to Dr. Edward Palmer for specimens from Utah lake, and to Mr. Henry Hemphill for specimens from Bear river, also in Utah Territory. These localities are in the Wahsatch range, at an elevation of over 4,500 feet above the level of the sea.

The differences between the specimens from these two localities are these: The river shells present a somewhat more ovate outline, are rather more elongated transversely, and are darker colored than the lake specimens. These Bear river mussels are so exactly like those collected by Mr. C. D. Voy in Washoe lake, which has an elevation of 4,000 feet in the Sierra Nevada, that though the two regions are separated by between seven and eight degrees of longitude, if numbers of individuals of the same sizes from these two localities were mixed without previous marking, they could not be segregated, with any degree of certainty, so closely are they alike in form, color, incremental lines and zones, which warrants the assumption that the factors of the environment are the same at both stations.

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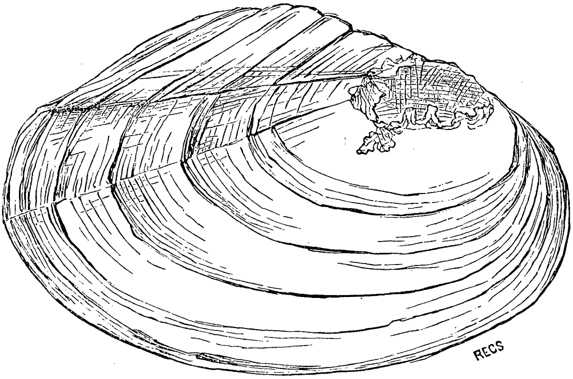
[1] The Owen's lake has no outlet and is fed by the Owen's river, a stream about thirty feet wide, two feet deep and having a velocity of about five miles per hour. As the level of the lake remains constant, there must be perfect equilibrium between the amount of evaporation and the incoming water. The lake having one hundred and ten square miles of surface, and evaporation of 4.6 feet per year, would suffice to swallow up the annual volume of Owen's river.

Those who cannot appreciate the amount of evaporation, have invented the hypothesis of a subterranean outlet, as in the case of the Great Salt Lake in Utah.—*Wheeler's Annual Report, 1876, p. 189.*

[2] Explanatory of my allusions to variation, herein, as shown by a comparison of the Anodons from one place with those from another, to prevent misapprehension I should state, that I do not regard variation as exhibited in the West American forms under discussion, as of specific value, a conclusion I have arrived at after a long and careful study of the relation of variation to environment. While forms or colonies of a form belonging unquestionably to the same species, and inhabiting stations only a short distance apart, often exhibit aspects of variation in such a degree as to appear phenomenal, the cause thereof not being immediately obvious, a careful investigation of the environment frequently rewards us, if not with a full explanation, with a clue or a ray of light.



Anodonta. Bear River, Utah Territory.

The fragments of *Anodontæ*, met with in the desert, are portions of shells (valves) having the same outline as that figured and described by Dr. Lea, in 1852,[1] from specimens collected by Dr. J. L. LeConte of Philadelphia, in the "Rio Colorado, California," and which Lea remarks as closely allied to "*An. nuttalliana*" from the "Wahlamet river, Oregon," previously described by that author.[2]

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[1] Trans. Am. Phil. Society, 2d Series, Vol. x.

[2] Eight species of fresh water mussels have been described from Western North America, west of the Rocky mountains and north of Mexico; of these six belong to the group *Anodonta*; of these six *Anodons*, four, namely *A. nuttalliana*, *A. wahlamatensis*, *A. oregonensis* and *A. californiensis*, are regarded by me as varieties of one and the same species.

In a paper "On the variation of the fresh water mussels," etc., of this western region of America, now nearly ready for the press, I point out the features of their variation and indicate the influences which have induced it. Seven of the eight species alluded to, were described by Dr. Lea.

The remarkable season of 1861-2, when the great California basin was flooded and the larger portion of the valleys included between the coast range and the Sierra Nevada was for weeks covered with water, and connected at times, so as to form an extensive lake, this winter also embraced within the area of its severity the more interior basin east of the Sierra. While, doubtless, the volume of the Colorado was greatly increased through the contributions of its tributaries in its upper portion, it also must have received an extraordinary supply from the drainage slopes farther to the south. The record of unusually high water or floods in the Colorado includes the winter of 1861-2 as well as several seasons not remarkably wet in California. In the preliminary report of Lieut. Bergland,[1] on the feasibility of diverting the Colorado for the purposes of irrigation, he estimates the area of depression below the sea level within the limits of California at approximately " 1,600 square miles," yet during the severe winter especially referred to, an area estimated to be sixty miles long by thirty miles wide was covered with water.[2] A portion of this was without question the surplus surface drainage from the adjacent country as well as the overflow of the Colorado, though the New River channel, and the main stream may have poured a portion of its water, in times gone by, over the desert, through other channels.

The sedimentary deposit under consideration and the lake whose waters once held it in suspension, and covered the present desert, may be accounted for in this way, and its permanence, over the area covered and the depth of water on which its area depended, only required a more constant volume in the Colorado, a less rapid rate of evaporation, even if the topographical features are the same now as then.

With the data accumulated by various intelligent and trustworthy observers, and accessible to all who are disposed to investigate, we are justified in the conclusion that without spasmodic

[1] Wheeler's Report, 1876, p. 109.

[2] Mr. Jaeger, owner of the Ferry at Fort Yuma, and a resident of the place since its establishment as a military post, says, " Heavy floods in 1840, 1852, 1859, 1862 and 1867. Tasted the water flowing in channel at New River station in 1862, and found it fresh water. A Mr. Jones (now dead) told me that he came along the west side of the great basin in 1862, on his way from San Bernardino to New River, and saw in the basin a great lake, some sixty miles long by thirty wide. This came from the overflow in 1862." Id. 118.

or catastrophic action, the present condition of the desert is the result of gradual and slowly working causes, and that within comparatively recent times, there has been a decreasing mean average rain and snowfall to the north, in the higher regions which are drained in this direction, and also an increasing but gradual elevation combined with increased evaporation.

While *Tryonia* as before stated is apparently local, the other species are widely distributed. The *Anodontæ* (mussels) not only inhabited the area from the Wahsatch mountains on the east, to the Pacific ocean on the west, but from the Colorado on the south to and north of the Columbia river in the north, their migration in the latter direction having been from the Wahsatch region also, as appears probable when we consider the statement of Dr. James Blake,[1] "that the divide between the waters of the Great Basin and of the Columbia is the ridge * * * in latitude 41° 33′ N., longitude 113° 29′ E., * * * 600 feet (in height) above the level of the Salt Lake basin." And further he remarks "the height of the divide above the level of Queen's River valley is about six hundred feet, but I am of the opinion that other outlets must exist, which allowed the waters of the basin to attain a still lower level, before their disappearance solely by evaporation began. There must have been a large body of water left to disappear by evaporation, as the concretionary deposits * * * are found at an elevation of two hundred feet above the level of the valley and they could only have been deposited as the water became concentrated by evaporation. * * * Large numbers of *Anodonta* shells are found on the surface of the ground, entirely encased in this concretionary substance, to the thickness of two or three inches."

Of the two forms of *Planorbis* (*P. gracilentus* Gould, found dead in the desert, and *P. ammon* Gould, found living in the Colorado river) one is closely similar to other widely distributed forms, to which authors have given many specific names, but which I regard as varieties only of one and the same species. The *Physa* (*P. humerosa*), also though a well marked form in certain respects, I am inclined to place as simply a southern or warm climate variety of the widespread *P. heterostropha* Say, which inhabits an area extending from the Atlantic seaboard, to the Great Slave lake in the north, to the Pacific coast on the west, and is found also in Utah Lake.

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[1] Proc. Cal. Acad. Sci. Vol. iv. (p. 277, Oct.) 1872.

Dr. Hayden believes that his parties have fixed the position of the ancient outlet of the great lake that once filled the Salt Lake basin. This appears to have formerly drained into the Columbia river; and the lowest pass between the great basin and the drainage of the river is continued directly south at the head of Marsh creek, and so low is it that one marsh connects two streams, one flowing to the Bear river and the Great Lake, and the other to the Portneuf and Snake rivers of the Columbia. This generalization was actually made several years ago, but only fully established during the past season.—*Harper's Weekly, March 2d, 1878.*

And here I would remark that I do not assert that the distribution of these several molluscan forms may not have been through other channels and by other lines; from the Sierra perhaps, down its eastern flank or from some point or points in the coast range further to the east.

There are other agencies and methods of distribution, which I will refer to briefly, before closing. The *Anodontæ*, for instance, when young, sometimes attach themselves, by their valves, to the fins of fishes, and are carried to new localities in this way, as well as by being swept along by streams. Physa and Planorbis in their embryonic stage are contained in a soft and sticky mass of jelly; this gelatinous mass adheres to the legs and feathers of birds, especially aquatic species, and is carried often to great distances from the original habitat; again tornadoes and water spouts act as distributing agents, taking up the waters of lakes and streams, and the chips and twigs which frequently abound therein, and transporting the same to places many miles away, where they are deposited, sometimes, in other streams or ponds. It is quite common to find the sticky egg-mass as well as adult individuals of the fresh water snails, adhering to such objects.

And now after a somewhat prolonged and perhaps tiresome journey over a rather wide region, pursuing such suggestions as have been evolved from time to time during the progress of our inquiry, let us return to the place of beginning, where I will conclude by repeating the noteworthy facts, perhaps without parallel elsewhere, namely the level of the Southern Pacific Railroad in the Colorado desert, as compared with that of the ocean. Here we have several miles of railway upon a plane nearly 200 feet below the sea level, and locomotives supplied with fresh water from a well 240 feet below the level of the ocean; the latter, if not the deepest, being certainly one of the remarkable wells of the world.